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HAZARDOUS
SITE CONTROL
DIVISION

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Ecology & Environment

HYDROGEOLOGIC REPORT
ON THE
SAND PARK LANDFILL
LOVES PARK, ILLINOIS

TDD: R05-8303-01G

SEPTEMBER 8, 1986

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REFERENCE 2
SITE NAME SAND PARK LANDfill
SITE ID ILD980606673

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1. INTRODUCTION

Sand Park Landfill is a closed 22-acre landfill located in Loves Park, Illinois. Halogenated and nonhalogenated degreasing solvents and plating wastes containing cyanides and heavy metals may be present at the site. Previous investigations suggest that this landfill may be a source of chemical contamination of local groundwater.

Based on the potential for contaminant migration from the site via groundwater, the site received a preliminary score of 31.6 under the Hazard Ranking System (HRS) model. This score qualifies the site for possible inclusion on the National Priorities List (NPL) under criteria developed by the U.S. Environmental Protection Agency (U.S. EPA). In order to obtain this score, the source of contamination must be identified. Subsequently a hydrogeologic field investigation was undertaken at the Sand Park site.

The objectives of this study were:

- To determine the lateral and vertical extent of contamination,
- To determine whether Sand Park is a source of contamination,
- To observe groundwater flow characteristics, and
- To determine the potential impact of contamination on the Loves Park municipal water supply.

The scope of work for this investigation included:

- Conducting soil borings and installing two upgradient monitoring wells,
- Measuring groundwater elevations,
- Determining in situ hydraulic conductivities of aquifer materials,
- Analyzing groundwater samples for priority pollutants, and
- Preparing a hydrogeologic report based on geologic and groundwater sample data.

This investigation was completed under Technical Directive Document (TDD) R05-8303-01G, issued November 2, 1984.

2. SITE BACKGROUND

2.1 SITE DESCRIPTION

Sand Park Landfill occupies 22 acres in T.44N., R.2E., SW 1/4, Sec. 6 in Loves Park, Winnebago County, Illinois. The site location is illustrated in Figure 2-1. The landfill is bordered on the north by Riverside Boulevard, on the east by Chicago and Northwestern Railroad tracks, on the west by Walker Road, and on the south by Marshall Middle School. The Rock River is approximately 1.5 miles west of the site.

2.2 GEOGRAPHY

Winnebago County is characterized by broad, rolling uplands, rising 100 to 200 feet above numerous alluviated valleys. Relatively level undissected divides occupy the uplands between these valleys. Local relief usually does not exceed 40 feet.

The Rock River forms the major drainage way for the Loves Park area and is the center of a well-integrated regional drainage system. Sand Park lies immediately west of the eastern bluff line of the Rock River Valley.

2.2.1 Physiography

The Sand Park terrain slopes gently west-southwest toward the Rock River. Total natural relief across the site does not exceed 25 feet. The average slope is approximately 1 percent. The most

SOURCE USGS ROCKFORD NORTH, IL QUAD

SCALE

0 0.5 1 MILE

0 0.5 1 KILOMETER

FIGURE 2—1 SITE LOCATION MAP

prominent topographic feature of the immediate area is the landfill, which is a large circular mound standing approximately 60 feet above grade in the center of the site.

2.2.2 Land Use

The site is presently used as a public park. A community swimming pool with attendant bath house and parking lot is located on the property. The refuse mound is used as a tobaggan slide during winter months. The surrounding area is comprised of a mixture of residential, commercial, and light industrial buildings. The principal features of the site are illustrated on Figure 2-2.

2.2.3 Climate

Winnebago County has a continental climate with warm summers and cold winters. The average winter temperature is 23° F and the average summer temperature is 71° F (Grantham 1980). The mean annual precipitation is approximately 35 inches; the mean annual pan and lake evaporation, 30 inches; and the resulting net annual precipitation, 5 inches. Sixty-six percent of the total annual precipitation usually falls in April through September. The prevailing wind originates from the west-northwest.

2.2.4 Infrastructure

Approximately 18 municipal wells [redacted] These wells are owned by Loves Park, North Park, and the City of Rockford. The wells draw water from the glacial drift aquifer and from numerous bedrock aquifers found in the region. Together these wells serve a population in excess of 30,000 people. Two Loves Park wells [redacted].

2.3 REGIONAL GEOLOGY

Sand Park lies within the glaciated region of northern Illinois and was completely covered by continental glaciers which advanced from central and eastern Canada during the Pleistocene Epoch. Unconsolidated materials left by the glaciers are generally thin or absent on the uplands where glacial till and loess were deposited, but are more than 200 feet thick in the three major bedrock valleys in the

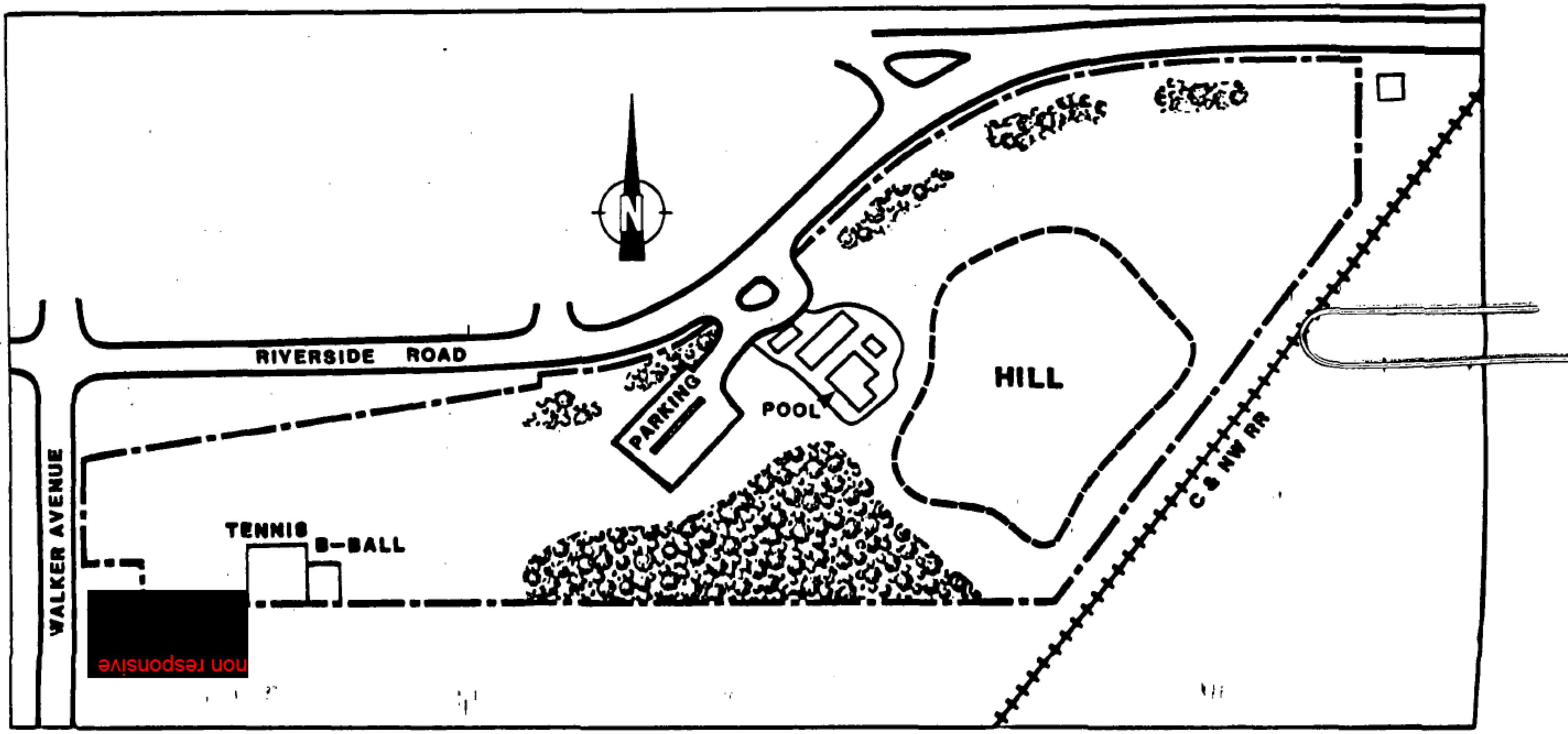

FIGURE 2-2 SITE FEATURES MAP

county. These valleys, which formed prior to glaciation of the region, were filled with sand and gravel outwash deposits from the melt waters of several Wisconsinan age glacial advances. These outwash deposits typically lie directly above Paleozoic bedrock formations of Ordovician age. The upper bedrock formations are dolomites of the Galena, Decorah, and Platteville formations. They are composed of light-gray or brown, finely crystalline dolomite. These bedrock formations form one of the principal aquifers in the region, yielding groundwater through well-developed joint and fracture systems, bedding planes, and solution cavities. Below this is the Glenwood Formation, which consists of interbedded dolomite, sandstone, and shale. Thickness of the Glenwood Formation ranges from 10 to 60 feet. It has little value as an aquifer and, where shales are present, may act as a local aquitard. The St. Peter Sandstone underlies the Glenwood Formation and all of Winnebago County. This formation directly underlies the glacial drift in the deep bedrock valleys (i.e., Rock, Pecatonica, and Troy). The St. Peter is fine- to coarse-grained, friable, and contains a high percentage of well-rounded, frosted quartz grains.

Bedrock formations below the St. Peter Sandstone are limestones, dolomites, and sandstones of Cambrian age. Both Ordovician and Cambrian age formations are widely utilized as aquifers throughout northern Illinois. The stratigraphy and hydrogeologic usage of bedrock and glacial units in Winnebago County is presented in Figure 2-3.

2.4 SITE HISTORY

Little is known about the early operating history of this site. A topographic map, obtained from the Rockford Park District, indicates that the site was used as a sand and gravel pit prior to 1943. At that time the pit was approximately 20 feet deep. From 1943 to the present, the site has been owned by the Loves Park/Rockford Park District.

The first record from Illinois Environmental Protection Agency (IEPA) files indicating that waste was deposited at the site is a Winnebago Department of Public Health (WDPH) landfill registration form dated September 29, 1969. Aerial photographs taken in 1964 show that a large amount of waste was already present at the site. This

Figure 2-3

STRATIGRAPHY AND HYDROGEOLOGIC USAGE OF BEDROCK AND GLACIAL UNITS IN WINNEBAGO COUNTY

SYSTEM	MEGA-GROUP	GROUP	SUB-GROUP	FORMATION	USAGE OF HYDROGEOLOGIC UNIT			
QUATERNARY					GLACIA	DRIFT	AQUIFER	Probabilities of groundwater development are poor to excellent depending upon thickness of glacial deposits and grain size.
ORDOVICIAN	OTTAWA	GALENA PLATTEVILLE		DUBUQUE	BEDROCK AQUIFERS	ORDOVICIAN AQUIFERS		DOLOMITE AQUIFERS Principle source of water supply for various types of wells. Most wells finished 20 to 100 feet into dolomite. Average yields of 20 gallons per minute. Aquifers susceptible to pollution particularly in areas where glacial drift is less than 50 feet.
			KIMMSWICK	WISE LAKE				
				DUNLEITH				
			DECORAH	GUTTENBERG				
				SPECHTS FERRY				
			PLATIN	QUIMBYS MILL				SANDSTONE AQUIFERS Sandstone beds from basal unit of Glenwood formation downward yield water supplies up to 300 gpm. This widely used aquifer's yield depends upon sandstone bed thickness.
				NACHUSA				
				GRAND DETOUR				
				MIFFLIN				
		ANCELL		PECATONICA				
				GLENWOOD				
				ST. PETER				

Figure 2-3 (Cont.)

SYSTEM	MEGA-GROUP	GROUP	SUB-GROUP	FORMATION		USAGE OF HYDROGEOLOGIC UNI	
CAMBRIAN	KNOX DOL			JORDAN Ss		CAMBRIAN AQUIFERS	Permeability is low in this zone due to a large proportion of shale. Ground-water development potential is poor.
				EMINENCE			
				POSTOSI DOL.			
	POTSDAM SANDSTONE			FRANCONIA			SANDSTONE AQUIFER These principal sandstone aquifers are used for large capacity (up to 2000 gpm) industrial wells.
				IRONTON			
				GALESVILLE			
				EAU CLAIRE			
				MT. SIMON			

Compiled from Hackett (1960).

evidence indicates that waste was first accepted in the late 1950's or early 1960's.

Landfilling operations at the site were carried out by the Loves Park/Rockford Park District and Browning-Ferris Industries, Schaumburg, Illinois. Browning-Ferris operated in the eastern half of the site, while the Loves Park/Rockford Park District operated in the western half. The operating years for both operations are unknown. Landfilling continued until site capacity was reached. The landfill was closed in May 1972.

In March 1973, Novak, Dempsey & Associates conducted eight test borings on the area of the refuse hill used by Browning-Ferris. These borings indicated 6 inches of clay cover material followed by over 40 feet of refuse. Two feet of final clay cover was applied by Browning-Ferris in June 1975, covering only the sections of the site in which they operated. Final cover was not applied to areas in which the Loves Park/Rockford Park District operated.

In 1973 Novak, Dempsey & Associates also installed three methane gas vents around the refuse hill and along Riverside Boulevard. At least one of these vents is located near the Sand Park swimming pool.

In January 1982 IEPA detected volatile chlorinated solvents in a water sample obtained from Loves Park municipal well 2, [redacted] (see Figure 2-2). Additional sampling by IEPA in 1982 and 1983 revealed further contamination of well 2 and the contamination of Loves Park municipal well 1, [redacted] Sand Park was subsequently implicated as a cause of this contamination, thus prompting IEPA to conduct further studies at the site. These studies are discussed in Section 2.6 of this report.

In February 1984 Sand Park was identified as a potential site for FIT investigation in the form of a Preliminary Assessment (PA) submitted by IEPA to U.S. EPA. FIT was then tasked to conduct a site inspection at Sand Park and perform any on-site activities necessary to complete an HRS score. As part of those activities, FIT conducted the hydrogeologic investigation detailed in this report.

2.5 WASTE CHARACTERIZATION

Records from IEPA and Illinois Department of Public Health

(IDPH) indicate that hazardous wastes are present at the site, although waste types and amounts are not specified. An IEPA inter-office memorandum dated February 24, 1984 states that halogenated and nonhalogenated degreasing solvents and plating wastes containing cyanides and heavy metals may be present at the site. The date(s) of disposal of these wastes is also unknown.

2.6 PREVIOUS INVESTIGATIONS

Two previous studies have been conducted by IEPA at Sand Park. These investigations included a resistivity study and groundwater quality analysis. Previous FIT investigations included a site inspection and groundwater sampling from on-site monitoring wells.

2.6.1 IEPA Resistivity Study

In September 1982 an electrical earth resistivity study was conducted at Sand Park by IEPA. The study concluded that:

- A contamination plume was extending west from the Sand Park;
- Loves Park municipal well 2 could be threatened by this plume; and
- The fill area included portions of the site north of the refuse hill.

IEPA also recommended continued monitoring of Loves Park well 2 and installation of additional monitoring wells.

2.6.2 IEPA Groundwater Quality Monitoring

In 1974, as part of a final closure plan, downgradient monitoring well G-101 was installed in the glacial drift aquifer. Samples were taken quarterly and analyzed for chloride, iron, and residue upon evaporation (ROE). According to IEPA, iron and ROE were consistently above IEPA public consumption and food processing standards. G-101 has since been abandoned.

In April 1983 IEPA installed downgradient monitoring wells G-102, G-103, G-104, and G-105 as two nests of two wells each. Shallow wells G-103 and G-105 are approximately 20 feet deep. Deep wells G-102 and G-104 are approximately 50 feet deep. Boring logs for these wells are presented in Appendix A. These wells were monitored for inorganic constituents and a limited number of volatile organic compounds. None of the volatiles tested for were detected. Well G-105 showed slightly elevated levels of barium, iron, and ROE.

2.6.3 Previous E & E, FIT Investigations

Monitoring wells G-102, G-103, G-104, and G-105 were sampled by FIT during their site inspection on August 14, 1984. Results are discussed in Section 4.2 of this report.

3. PROCEDURES

3.1 INTRODUCTION

The following sections detail procedures utilized during the hydrogeologic investigation at the Sand Park Landfill.

3.2 HYDROGEOLOGIC INVESTIGATION

3.2.1 Borings

Soil borings were completed by Canonie Construction Company, Itasca, Illinois, using a truck-mounted, Mobile B-40 drill rig. Work was conducted from January 3 to January 9, 1985 and was supervised by E & E, FIT personnel. Boring locations are shown in Figure 3-1. Upgradient borings G-106 and G-107 were the only borings completed during this project. A combination of 3 3/4-inch inside diameter (ID) hollow stem auger and rotary wash drilling techniques was used to advance both borings. Sand formation caving into the hollow stem augers necessitated the use of drilling mud in both borings. A guar-gum-based drilling fluid (Vari-Flow® from American Colloid Company) hydrated with City of Rockford municipal water was used as a drilling mud to hold fine- grained sand formations open below the water table. In both borings, drilling mud was flushed from the bore hole with clean water before well installation was completed.

Soil samples were collected with a 2-inch outside diameter (OD) split-spoon sampler for visual classification of soil samples. Standard penetration tests in advance of the auger tip or rotary bit

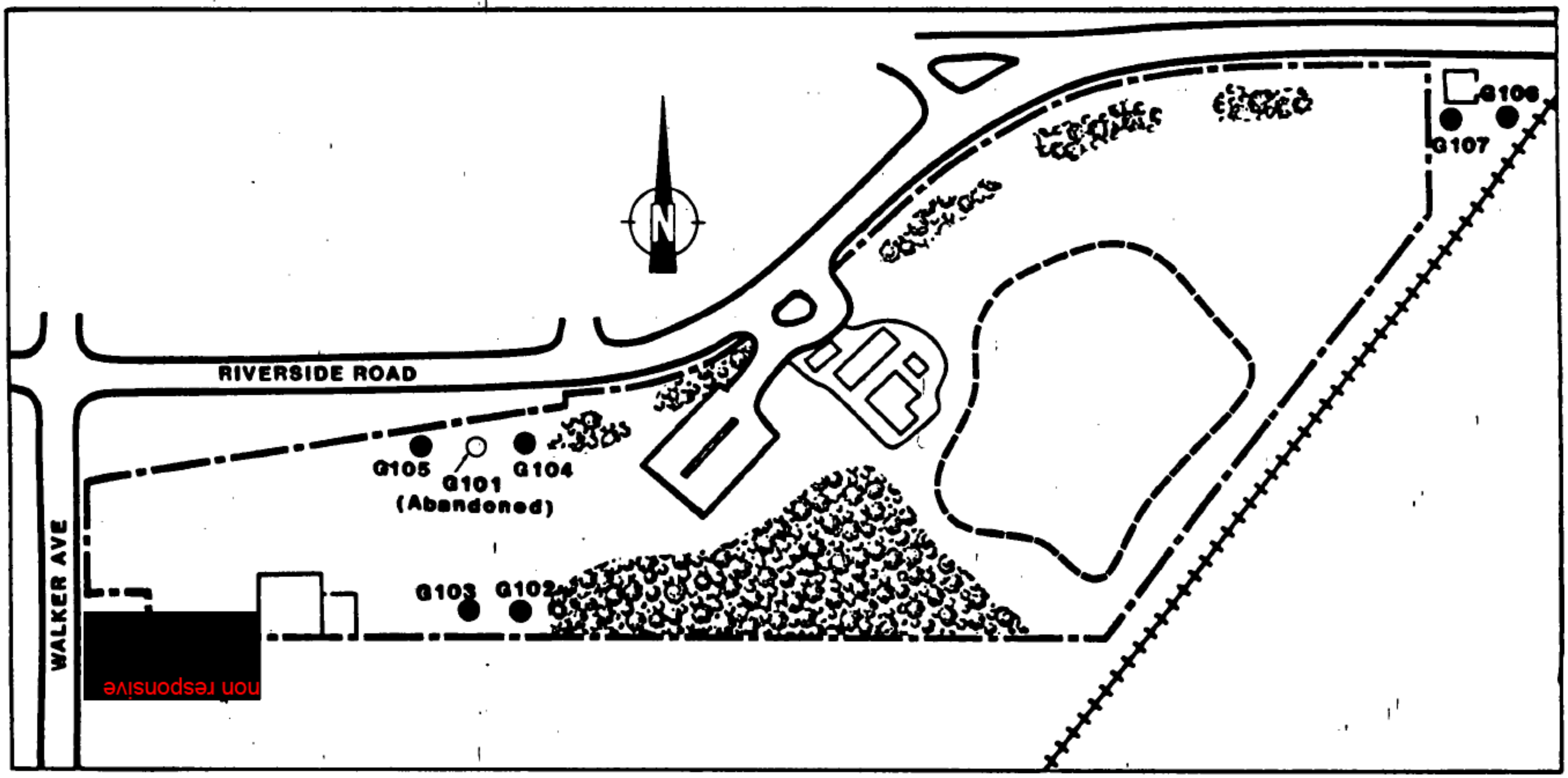

FIGURE 3—1 MONITORING WELL LOCATION MAP

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were performed in accordance with American Society for Testing Materials (ASTM) standards. In deep boring G-106, split-spoon samples were collected at 2 1/2-foot intervals from 0 to 10 feet and then at 5-foot intervals from 10 to 60 feet. In shallow boring G-107, split-spoon samples were taken from 35 to 43 feet only, to insure that the well screen would be placed in a water-bearing formation.

No soil samples were collected for chemical analysis. Drill cuttings and soil samples were monitored for organic contaminants with an HNU monitor. (No readings above background were detected.) Boring logs with detailed stratigraphic and lithologic descriptions are presented in Appendix A.

3.2.2 Monitoring Well Construction

The FIT monitoring wells were installed in borings G-106 and G-107 to provide upgradient sampling points at this site. The wells were emplaced as a well nest consisting of one deep and one shallow well. Wells G-106 and G-107 are 61.5 and 43 feet deep, respectively. FIT monitoring wells terminate in the same saturated zone as the IEPA wells (G-102, G-103, G-104, G-105) located downgradient of the fill area.

FIT wells were constructed with 2-inch (ID) threaded, flush-jointed PVC casing conforming to Schedule 40 ASTM standards. Screens were also constructed from PVC and were factory slotted with 0.010-inch slots. A 5-foot screen length was used at each well. Each well screen was surrounded by a natural sand and gravel filter pack. This filter pack formed as sand and gravel collapsed around the screen when hollow stem augers were pulled or drilling mud was flushed from the bore hole. In each well, collapse of the bore hole was allowed to occur up to a few feet above the water table. A 2-foot-thick bentonite pellet seal was then placed around the well casing. The remainder of the annulus was grouted to the surface using a thick cement and bentonite slurry. To complete the installation, a locking, 4-inch (ID), steel outer protective casing was placed over the well casing and embedded in the grout. A concrete plug was placed around the protective casing at ground surface to prevent storm run-off or surface water from entering the bore hole. General well construction is illustrated in Figure 3-2.

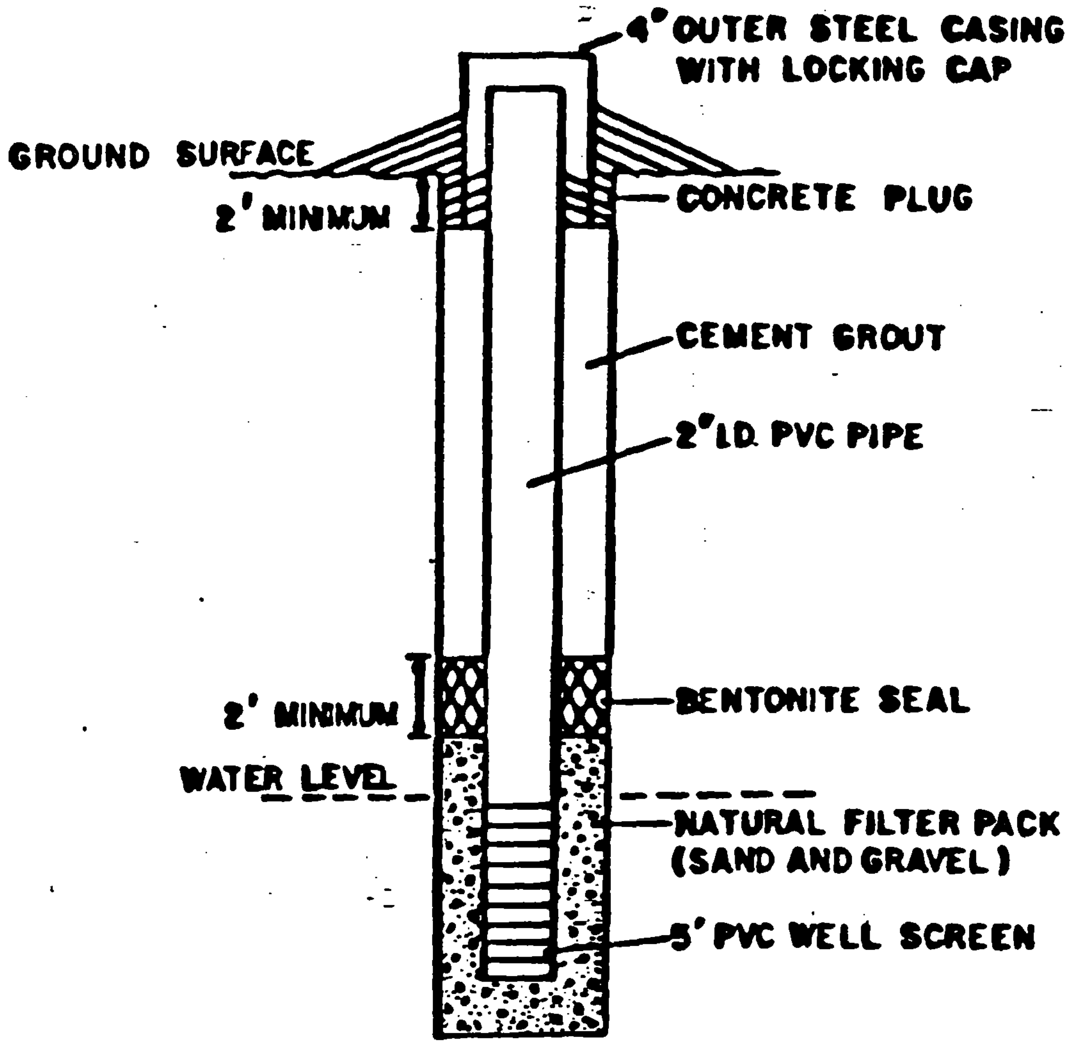

Figure 3–2 Typical groundwater monitoring well.

Upon completion, all IEPA and FIT wells were surveyed to determine elevation above Mean Sea Level (MSL). Elevations were measured from the top of the PVC casing.

In accordance with contract specifications, the drill rig and all drilling and sampling tools were decontaminated with a hot water pressure wash system prior to mobilization on-site. In addition, the split-spoon sampler was scrubbed in clean water between each boring. All equipment was again steam cleaned at the completion of drilling activities.

Both FIT wells were developed by the surge and bail method using a 3-foot stainless steel bailer. Ten well volumes were removed from each well.

3.2.3 Aquifer Measurements

3.2.3.1 Water Level Measurements

Water levels were measured in all on-site monitoring wells on January 9 and April 1, 1985. On June 6, 1985 water levels were measured in wells G-104, G105, G-106, and G-107 only. Wells G-102 and G-103 were not measured on that date because they had been destroyed by vandals at some time between April 1 and June 6, 1985. A chalked graduated stainless steel tape was used for each measurement. All water levels were measured from the top of the inner PVC well casing. Water level measurements were used to determine both horizontal and vertical groundwater flow directions and horizontal and vertical flow gradients within the aquifer.

3.2.3.2 Hydraulic Conductivity Testing

On June 6, 1985 the in situ hydraulic conductivities of aquifer materials were determined by performing rising-head slug tests in wells G-104, G-105, G-106, and G-107. Wells G-102 and G-103 were not tested because of damage due to vandalism. Results from tests were used to evaluate the potential for contaminant migration through the aquifer and calculate groundwater velocities.

In this test, a water tight cylinder attached to a stainless steel cable was inserted into the well and positioned below the water table. By inserting the cylinder, a known volume of water was displaced, thereby raising the water level in the well. After the water level had stablized back to its static level, the cylinder was then instantaneously removed from the well. By removing this cylinder, the water level was depressed by a known volume below the static level, and the test was allowed to begin. Water levels were then measured at predetermined time intervals as they rose to the static level.

Water level data was collected with a SE1000A hydraulic pressure transducer, manufactured by In-Situ, Inc., Laramie, Wyoming. A 1 1/4-inch (OD) sand-filled PVC slug was used to depress the static water level in all wells.

3.2.3.3 Groundwater Sampling

All IEPA and FIT wells were sampled on April 1, 1985. Prior to sampling, five well volumes were removed from each well with an airlift pump system. All samples were collected with a bottom-loading stainless steel bailer. Samples for organic analysis were iced to 4°C immediately upon collection. All samples for inorganic analysis were field-filtered with a 45-micron filter and preserved with nitric acid. An additional 1-liter volume was collected from each well for cyanide analysis. This sample was preserved with sodium hydroxide. A full priority pollutant scan was run on each sample.

Samples were shipped via an overnight delivery service to the U.S. EPA Contract Laboratory Program (CLP) laboratories, using standard U.S. EPA Chain-of-Custody procedures. Organic and inorganic analyses were conducted by California Analytical Laboratories, Inc., Sacramento, California, and Rocky Mountain Analytical, Arvada, Colorado, respectively.

4. RESULTS AND DISCUSSION

4.1 PHYSICAL RESULTS AND DISCUSSION

This section discusses the results of E & E, FIT soil boring, aquifer testing, and groundwater sampling efforts undertaken at the Sand Park site.

4.1.1 Geology and Soils

The geology and soil characteristics of the Sand Park site were determined by a review of available geologic literature and the results of soil borings conducted by FIT and IEPA.

Results

The boring logs for FIT wells G-106 and G-107 and IEPA wells G-102, G-103, G-104, and G-105 are presented in Appendix A.

The stratigraphic soil sequence in boring G-106 was as follows:

0-14.0 ft.	Sandy silty clay. Fill material.
14.0-20.5 ft.	Brown silty clay.
20.5-21.5 ft.	Sand and gravel seam. Saturated.
21.5-34.0 ft.	Gray clay and brown silt.
34.0-60.0 ft.	Brown fine sand. Saturated.
60.0-61.5 ft.	Gray silty clay.

Boring G-107 was drilled approximately 8 feet west of G-106. No samples were taken, but observation of auger cuttings indicated a similar soil sequence. Borings G-106 and G-107 were completed at 61.5 feet and 43.0 feet, respectively.

IEPA borings G-102 and G-104 were both completed at 51.5 feet below ground surface. G-103 and G-105 were both completed at 17.5 feet. In G-102 and G-104, fine- to coarse-grained sand and/or sand and gravel was encountered from the surface to approximately 50 feet. A very tight, gray silty clay was encountered below this depth to termination of the boring at 51.5 feet. G-103 and G-105 penetrated similar sand and gravel soils. No clay was encountered in either of these shallow borings.

Discussion

In general, a review of the literature indicates that Sand Park is located on the eastern slope of a deep pre-glacial bedrock valley that has been filled with thick deposits of sand, pebbly sand, and gravel. These sands and gravels are representative of the valley train deposits that resulted from numerous Wisconsinan age glacial advances that moved across Winnebago County approximately 75,000 years ago. They are identified as the Makinaw member of the Henry Formation and consist of well-sorted, regularly bedded, tan to light brown fine sands and small to medium gravels.

The boring log for Loves Park municipal well 2, [redacted] indicates that these sand and gravel deposits extend to a depth of at least 203 feet. Other logs for wells in the vicinity show that this formation continues uninterrupted to a depth of 250-300 feet, where St. Peter Sandstone is encountered directly below the sand and gravel.

A geologic cross-section was prepared (Figures 4-1, 4-2) using boring logs from Loves Park municipal well 2, IEPA well G-104, a private production well, and FIT well G-106. This cross-section reveals a continuous clay layer below the site. Borings from wells G-102, G-104, and G-106 did not penetrate this clay layer. The well log for Loves Park well 2 indicates that this layer is approximately 20 feet thick. All monitoring wells were screened in the sand and gravel layer above this clay.

Boring logs for private and municipal wells [redacted] were reviewed to determine the horizontal extent of this clay layer. Although the clay is extensive in the immediate area of the site, the review produced boring logs that did not encounter this layer. This suggests that the clay is discontinuous within the 3-mile radius. It was also noted that thin seams of clay and silt are commonly interbedded with the sand and gravel

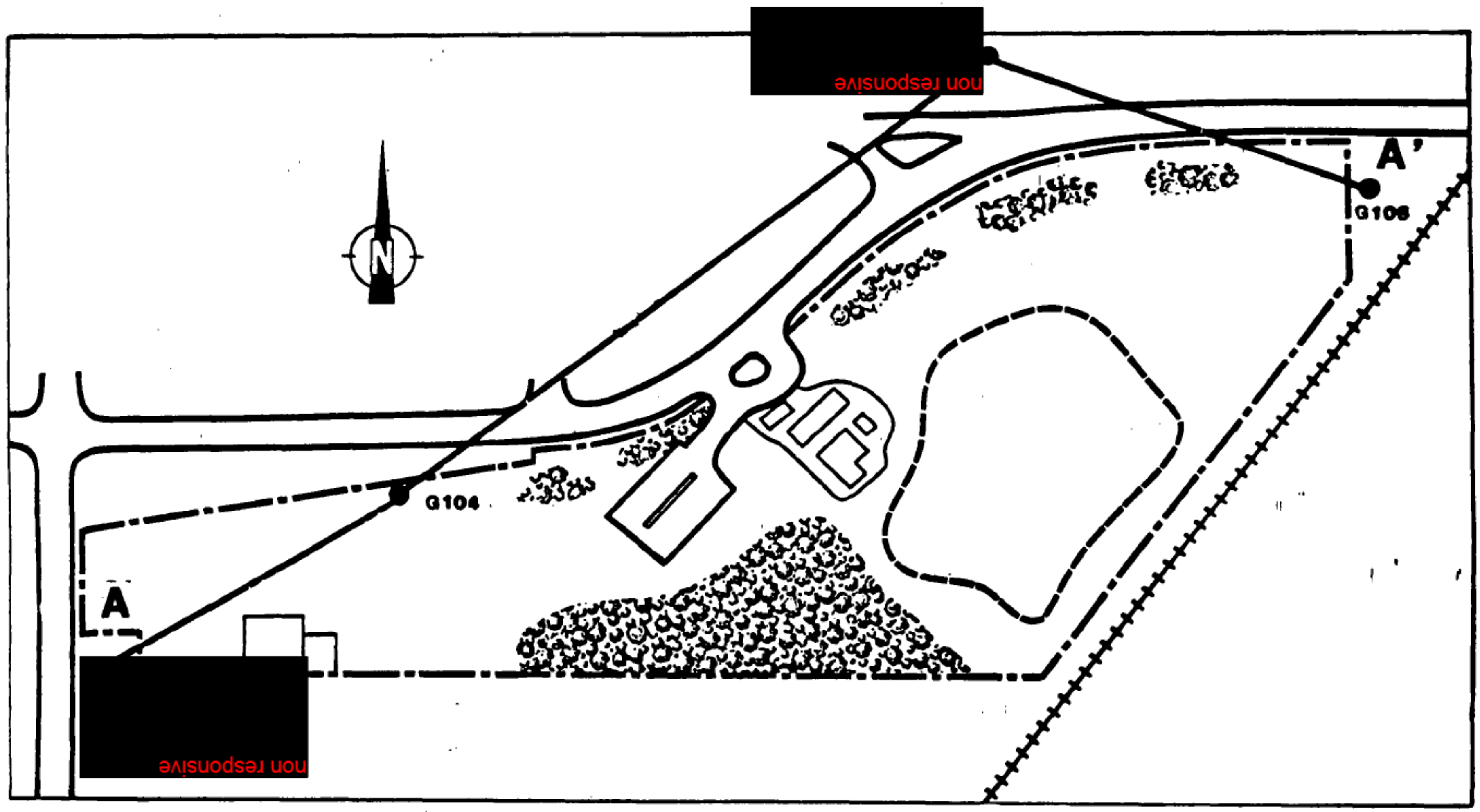

FIGURE 4—1 GEOLOGIC CROSS—SECTION LOCATION MAP

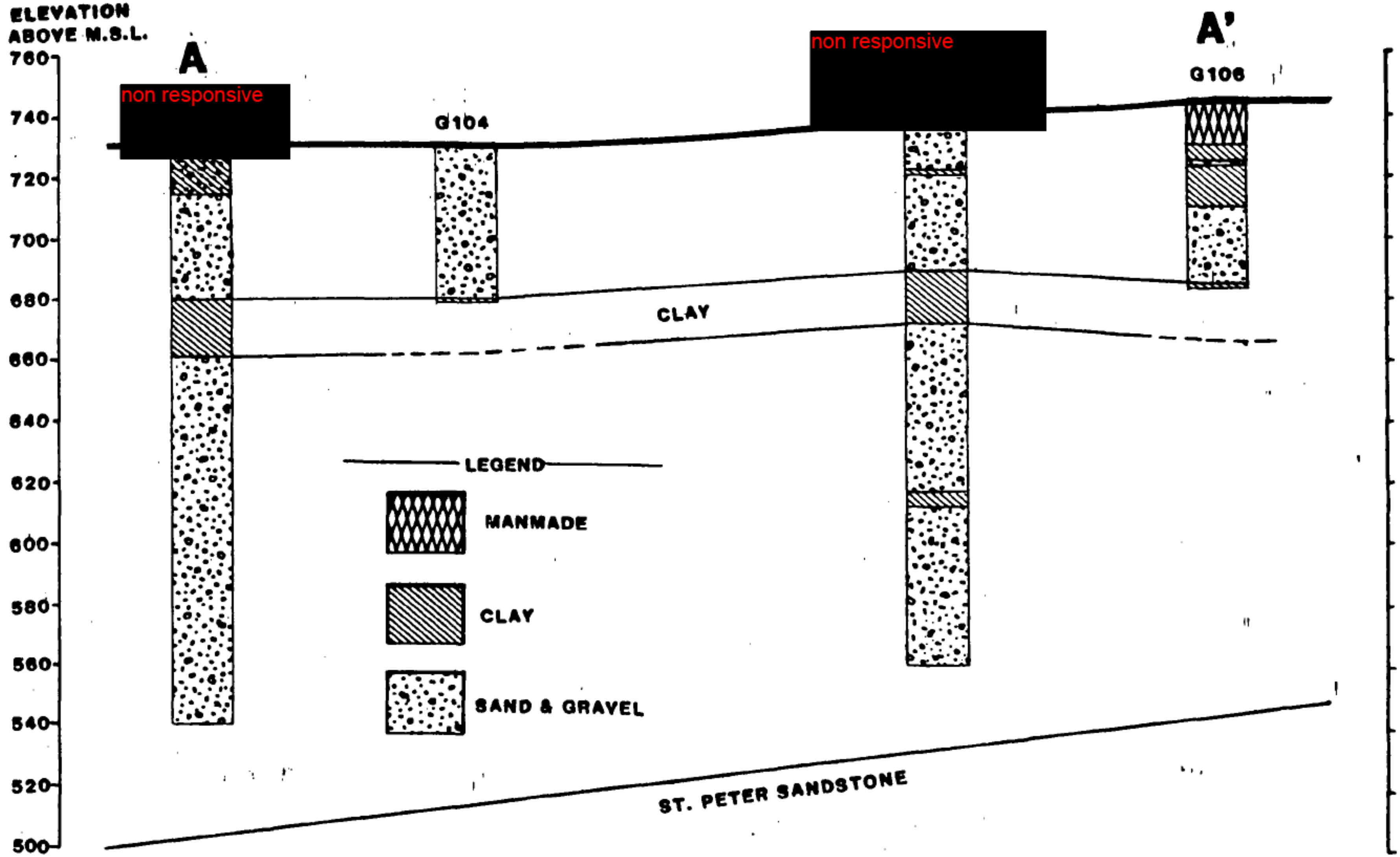

FIGURE 4-2GEOLOGIC CROSS-SECTION A-A'

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deposits throughout the radius, although none seem to be continuous.

4.1.2 Hydrogeology

Groundwater was encountered in the sand and gravel formation below the site. Water level elevations and hydraulic conductivities were measured in the field in order to determine groundwater flow direction, horizontal and vertical hydraulic gradients, and groundwater velocity.

4.1.2.1 Groundwater Flow

Results

Water level elevations were measured with a chalked stainless tape and were then used to determine the direction of groundwater flow at the site. Groundwater elevations and dates of measurement are shown in Table 4-1.

The direction of groundwater flow was determined using a triangulation method as outlined by Heath (1983). The direction of flow was calculated using the groundwater elevations measured on January 9 and April 1, 1985. Direction of flow could not be calculated for June 6 because wells G-102 and G-103 had been vandalized. Groundwater elevations measured in the deep wells were used to calculate flow direction through the lower portion of the aquifer, and elevations measured in the shallow wells were similary used to calculate flow in the upper portions of the aquifer. Groundwater flow direction is illustrated in Figure 4-3.

Discussion

In each case, groundwater was determined to be moving in a northwest direction, toward the Rock River. The Rock River serves as a major discharge point for groundwater in the glacial drift aquifer.

4.1.2.2 Hydraulic Gradients

Results

Horizontal hydraulic gradients were also calculated using the triangulation method outlined by Heath (1983). The lateral hydraulic gradients calculated from the shallow well series range from 0.010 (January 9, 1985) to 0.007 (April 1, 1985). The gradient on June 6 could not be calculated because wells G-102 and G-103 had been vandalized.

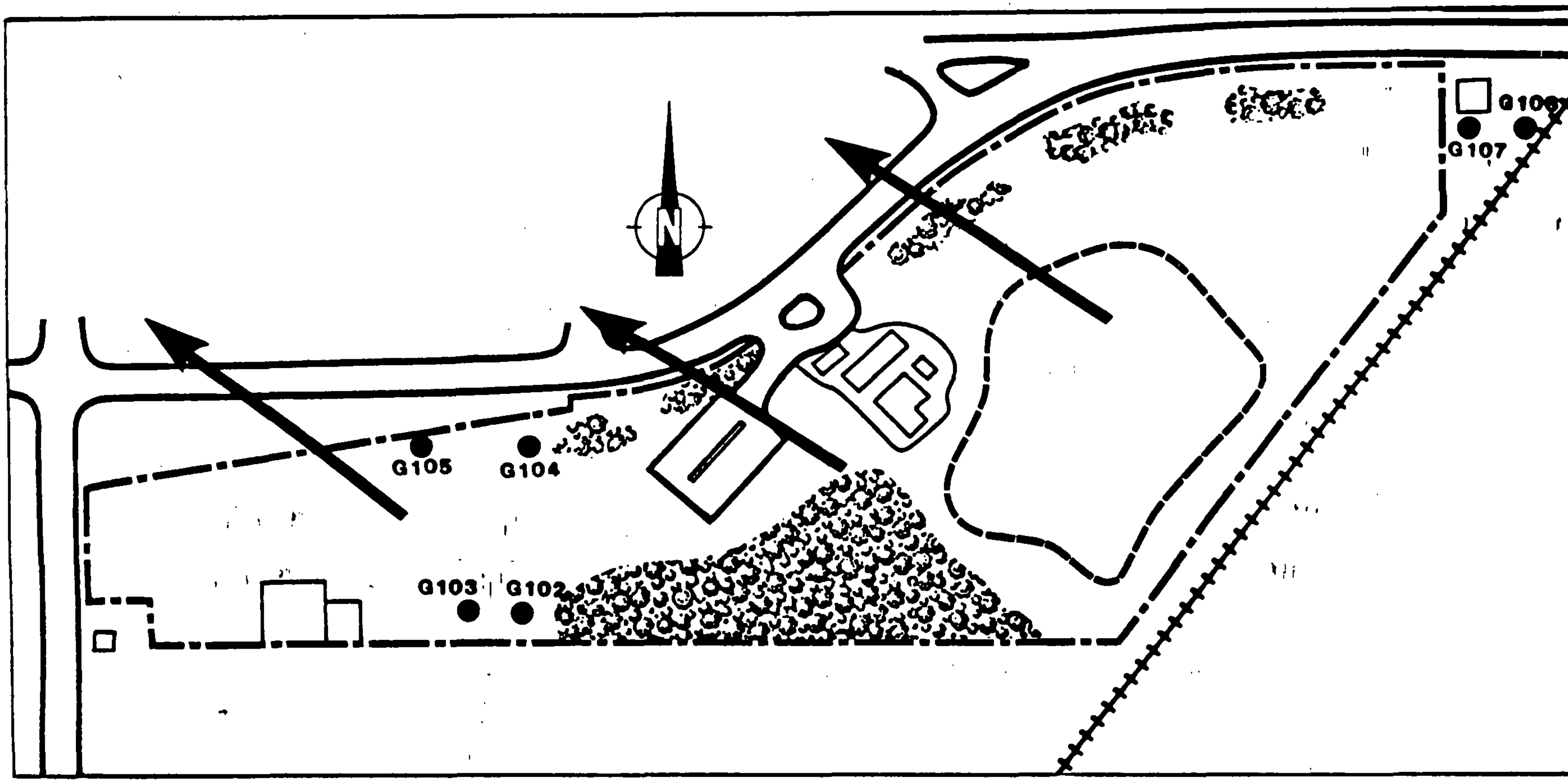
Table 4-1

GROUNDWATER ELEVATIONS
(Feet Above Mean Sea Level)

Monitoring Well	January 9, 1985	April 1, 1985	June 6, 1985
G-102 (Deep)	717.62	718.64	*
G-103 (Shallow)	717.60	718.62	*
G-104 (Deep)	715.24	716.41	715.79
G-105 (Shallow)	715.17	716.23	715.63
G-106 (Deep)	724.32	725.33	724.85
G-107 (Shallow)	724.23	725.27	724.79

* Vandalized wells.

Note: The reference point (740.594 feet above MSL) was the nearest USGS bench mark, a chiseled square in the southwest corner of the east walkway of the Material Road Bridge.



INDICATES FLOW DIRECTION

FIGURE 4—3 GROUNDWATER FLOW DIRECTION

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Water levels taken from the three nests of two wells each were used to determine the vertical gradients (dh/dl) within the aquifer. Using the vertical distance between well screens of the respective shallow and deep wells for dl and the head difference for dh, the vertical gradient was determined. The vertical gradients for all monitoring well nests within the study area are shown in Table 4-2. Vertical gradients are upward and range from -0.0006 at well nest G-102/G-103 to -0.0054 at well nest G-104/G-105.

Discussion

In general, the calculated gradients indicate that a weak mechanism exists which could prevent less dense contaminants from migrating deeper into the aquifer. In order for contaminants to penetrate the aquifer they would have to be sufficiently dense to overcome this upward vertical gradient. These gradients also indicate that portions of the aquifer are under discharge conditions, the discharge point being the nearby Rock River. Fluctuations should be expected as a result of precipitation or seasonal events.

4.1.2.3 Hydraulic Conductivities

Results

Field test data was analyzed using the Hvorslev (1951) technique for all wells. The Hvorslev technique assumes the following conditions: (1) the aquifer is unconfined; (2) the piezometer or well is of small diameter; and (3) the length of the screen is small compared with the length of the piezometer (Freeze and Cherry 1979). For the Hvorslev method, a regression technique was used to determine the equation for the best fit line which approximates the field test data. From this, the basic time lag was determined which in turn was used to calculate the horizontal hydraulic conductivity of aquifer materials adjacent to the well screen. Table 4-3 lists the calculated hydraulic conductivities at each monitoring well. Values ranged from 1.1 x 10^{-2} cm/sec to 5.5 x 10^{-3} cm/sec and had a calculated mean of 8.3 x 10^{-3} cm/sec.

Discussion

These values correspond to values given in the literature by Freeze and Cherry (1979) for a clean sand and gravel and were further substantiated by split-spoon samples of the same material taken in the

Table 4-2

VERTICAL HYDRAULIC GRADIENTS

Monitoring Well Nest	January 9, 1985	April 1, 1985	June 6, 1985
G-102/G-103	-0.0006	-0.0006	*
G-104/G-105	-0.0021	-0.0054	-0.0048
G-106/G-107	-0.0053	-0.0035	-0.0035

* Vandalized Wells.

Note: (-) indicates an upward vertical gradient.

Table 4-3

HYDRAULIC CONDUCTIVITY RATES

Monitoring Well	Hydraulic Conductivity (cm/sec)
G-102	*
G-103	*
G-104	4.6×10^{-3}
G-105	5.5×10^{-3}
G-106	1.1×10^{-2}
G-107	1.2×10^{-2}
Mean	8.3×10^{-3}

* Vandalized wells.

Note: Hydraulic conductivity rates can be converted to ft/sec by dividing cm/sec values by 30.48.

screened zone of each well. The value given for each well represents the conductivity of aquifer materials in the vicinity of the respective well screens. Hydraulic conductivities in this range indicate that the aquifer may be susceptible to contamination and conducive to the transport of contaminants away from the source area.

4.1.2.4 Groundwater Velocities

Results

Groundwater velocity in the aquifer is a function of the hydraulic conductivity of the aquifer, the lateral hydraulic gradient, and the effective porosity of aquifer materials.

An approximation of the velocity, V, at which the groundwater moves through the aquifer can be calculated using Darcy's equation. For laminar flow in saturated conditions:

$$V = K \times \frac{dh}{dl} \times \frac{1}{NE},$$

where: K = Hydraulic conductivity,

$\frac{dh}{dl}$ = Horizontal hydraulic gradient,

NE = Effective porosity.

In this case, K = 2.8 x 10^{-4} ft/sec (average for all wells) and dh/dl = 0.0085 (average horizontal gradient). The effective porosity (NE) cannot be determined directly although it can be approximated for a given material by the specific yield (SY). For a fine to medium sand, SY = 0.25 (Johnson 1957). Using these values, an average groundwater velocity of 294 ft/yr was calculated for the Sand Park site.

Discussion

This value represents the average groundwater velocity as it flows in a northwest direction across the site. Seasonal variations can be expected and would be due to precipitation events and their effect on hydraulic gradients within the aquifer. Groundwater velocities in this range are consistent with those found in other sand and gravel aquifers. Given that contaminants move in the direction of groundwater flow and at velocities not exceeding the groundwater flow velocity, it can be assumed that any contamination in the aquifer could be transported substantial distances from the site.

Discussion

Benzene and chlorobenzene were detected in downgradient well G-105 during both rounds of sampling. This suggests that the upper portion of the aquifer, monitored by G-105, has been contaminated with these two compounds. The decrease in contaminant concentrations seen in the second round of sampling may be due to a number of factors These include, but are not limited to, the following:

- Contaminant concentrations may have decreased due to the lateral passage of concentration gradients within a contaminant plume;
- The contaminants may have been diluted by an increased volume of groundwater in an aquifer that is responsive to seasonal precipitation events;
- Chlorobenzene, which has a density greater than water, may be sinking through the aquifer, carrying benzene along with it;
- Both benzene and chlorobenzene are highly susceptible to biodegradation.

Further sampling would be required to define the present concentrations of benzene, chlorobenzene, and 1,4-dichlorobenzene in local groundwater.

In sampling round 2 (April 1, 1985), organic contaminants were also detected in wells G-102 and G-107. The bis(2-ethylhexyl)phthalate level in G-102 is suspect because the chemical is a known laboratory contaminant. Concentrations of pentachlorophenol, found in G-107, need to be further substantiated by additional sampling because of the "semi-quantitative" nature of the initial results.

4.2.2 Inorganic Analysis

Results

The inorganic results from sampling rounds 1 and 2 are presented in Table 4-4.

Discussion

A review of Table 4-4 indicates that inorganic contaminants are found in downgradient well G-105 at significantly higher concentrations than in upgradient wells G-106 and G-107 or downgradient wells

Table 4-4

CONCENTRATIONS OF INORGANIC GROUNDWATER CONTAMINANTS (ppb)

	Round 1, August 14, 1984						Round 2, April 1, 1985							
	G-102	G-103	G-104	Dup G-104	G-105	BLK	G-102	G-103	G-104	G-105	Dup G-105	G-106	G-107	BLK
Aluminum	-	-	-	-	-	-	33J	-	-	-	-	-	-	-
Antimony	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Arsenic	-	-	-	-	13	-	-	-	-	14	15	-	-	-
Barium	-	-	-	-	1,660	-	24J	37J	39J	482	510	59J	63J	-
Beryllium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cadmium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Calcium	NA	NA	NA	NA	NA	NA	76,400	81,900	80,700	107,000	109,000	68,000	105,000	-
Chromium	-	-	-	-	-	-	-	-	-	-	-	-	24	-
Cobalt	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Copper	-	-	-	-	-	-	-	-	-	6.4J	4.3J	4.5J	4.6J	45
Iron	366	281	1,080	781	13,600	106	332	496	1,200	15,700	16,900	361	343	183
Lead	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Magnesium	NA	NA	NA	NA	NA	NA	34,700	36,800	35,200	31,800	32,400	28,900	43,400	-
Manganese	206	196	247	253	177	-	177	108	280	354	332	50	4.6J	-
Mercury	-	-	1.8	-	-	-	-	-	-	-	-	-	-	-
Nickel	-	-	-	-	-	-	-	-	-	-	5.6J	-	-	12J
Potassium	NA	NA	NA	NA	NA	NA	1,270J	3,040J	2,600J	21,000	19,700	1,150J	1,520J	-
Selenium	-	5.8	2.0	7.6	-	5.8	-	-	-	-	-	-	-	-
Silver	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Sodium	NA	NA	NA	NA	NA	NA	5,500	23,300	12,400	24,000	24,100	7,350	14,200	-
Thallium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Tin	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vanadium	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zinc	104	19	33	18	39	39	7.4J	6.3J	7.5J	24	8.6J	9.2J	11J	5.8J
Cyanide	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Note: NA - Not analyzed
- - Not detected
J - Value below the Contract Required Detection Limit (Semi-Quantitative)

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G-102, G-103, and G-104. Well G-105 is contaminated with the following inorganic compounds: arsenic (15 ppb), barium (510 ppb), iron (16,900 ppb), and potassium (21,000 ppb). Elevated levels of arsenic, barium, and iron were detected in both rounds of sampling, indicating a persistent problem with these contaminants at this location. The field blank indicates that these contaminants were not introduced by the sampling team. The duplicate of G-105 taken in round 2 also contained concentrations comparable to the sample.

With the exception of chromium (24 ppb) in G-107, the remainder of the on-site wells contain inorganic constituents that are typically found in groundwaters of the Midwest. These include calcium, magnesium, manganese, and sodium. Although iron and potassium are also typical constituents of groundwater, concentrations of these metals were detected at levels at least 10 times greater in downgradient well G-105 than in upgradient well G-106, indicating a contamination problem with these metals.

Contaminant values for selenium and zinc in sampling round 1 should be used with caution because of blank contamination. Mercury was detected in sampling round 1 (1.8 ppb), but not in round 2.

In round 2 the field blank contained copper, iron, nickel, and zinc. With the exception of iron, values for these compounds are suspect. Iron values detected in the wells are useful because they are significantly higher than values found in the blank. The chromium contamination (24 ppb) in G-107 can not be attributed to this site because G-107 is an upgradient well.

4.2 CHEMICAL RESULTS AND DISCUSSION

This section discusses the chemical quality of groundwater at Sand Park as determined by FIT sampling efforts conducted at the site on April 1, 1985. Also included in this discussion are chemical results from a previous round of FIT sampling completed during the initial site inspection in August 1984. All samples were analyzed for priority pollutants and cyanide at U.S. EPA Contract Laboratory Program (CLP) laboratories. Complete results are presented in Appendix B.

4.2.1 Organic Analysis

Results

In sampling round 1 (August 14, 1984), groundwater samples were collected from IEPA wells G-102, G-103, G-104, and G-105 (FIT wells G-106 and G-107 had not yet been installed). A duplicate from G-104 and a field blank were also collected. Organic contaminants were identified and quantified in the following concentrations in downgradient wells G-102 and G-105:

G-102 - Bis(2-ethylhexyl)phthalate 13.4 ppb
G-105 - Benzene 10.9 ppb
Chlorobenzene 8.5 ppb

Organic compounds were not detected in any of the other samples.

In sampling round 2 (April 1, 1985), groundwater samples were collected from all monitoring wells, including G-106 and G-107. A duplicate from G-105 and a field blank were also collected. Organic contaminants were detected in the following concentrations:

G-105 - Benzene 3 ppb (J)
Chlorobenzene 4 ppb (J)
1,4-Dichlorobenzene 3 ppb (J)
G-107 - Pentachlorophenol 14 ppb (J)

The "J" footnote denotes that these compounds were identified in the sample, but at quantities below the Contract Required Detection Limits (CRDLs). The CRDLs are 5 ppb for benzene and chlorobenzene, 10 ppb for 1,4-dichlorobenzene, and 50 ppb for pentachlorophenol. Values for these compounds are therefore considered to be "semi-quantitative" by U.S. EPA.

5. CONCLUSIONS

5.1 INTRODUCTION

The findings and conclusions presented in the report are based on information gathered during a site background review, pertinent geologic literature review, and the hydrogeologic study conducted at the site.

5.2 FINDINGS

5.2.1 Site Background

- Sand Park is an old sand and gravel pit that has been filled with municipal refuse, construction debris, and unknown quantities and types of hazardous wastes.

- During landfilling operations, the site was owned and operated by the Loves Park/Rockford Park District. Browning-Ferris Industries also deposited waste in portions of the site.

- Sand Park was used as a landfill until closure in May 1972. Final cover was applied to only certain portions of the site. Presently this site is used as a city park by the Loves Park/Rockford Park District.

- Loves Park municipal well 2, [redacted] is contaminated with volatile chlorinated solvents.

5.2.2 Geology and Soils

- Sand Park is located on the eastern slope of a deep pre-glacial bedrock valley that has been filled with glacial outwash sand and gravel deposits. These deposits are over 200 feet thick.

- This bedrock valley roughly coincides with the present day valley formed by the Rock River.

- These sand and gravel deposits are commonly interbedded with clay and silt seams. Although some of these seams are extensive locally, none seem to represent a continuous layer throughout the 3-mile radius.

- Boring logs from wells on-site indicate that sand and gravel deposits are broken by a clay layer at 50 to 70 feet below the surface. Boring logs from the area suggest that this clay layer is continuous within approximately 1/2 mile of the site.

- Sand and gravel outwash deposits continue uninterrupted from the the clay layer down to the St. Peter Sandstone Formation.

5.2.3 Hydrogeology and Groundwater Quality

- For the purposes of this report, two aquifers exist in the sand and gravel deposits below the site: an upper aquifer above the clay layer and a lower aquifer below the clay layer.

- All monitoring wells on-site are nested, with wells at the top and bottom of the upper aquifer. Water level measurements indicate that groundwater is moving in a northwesterly direction towards the Rock River. Water levels in well nests also indicate that an upward vertical gradient exists in this aquifer.

- Sample results from downgradient monitoring well G-105 show that groundwater is contaminated with arsenic (15 ppb), barium (510 ppb), iron (16,100 ppb), and potassium (21,000 ppb). Benzene, chlorobenzene, and 1,4-dichlorobenzene were also detected in this well. However, concentrations of benzene and chlorobenzene decreased from highs of 10.9 ppb and 8.5 ppb in round 1, to below CRDLs in round 2.

- The remaining wells showed either no contamination or contamination in only 1 of the 2 sampling rounds.

5.3 GENERAL CONCLUSIONS

Based on the results of monitoring well sampling at the Sand Park site, groundwater in the upper aquifer has been contaminated with the following inorganic and organic compounds: arsenic, barium, iron, potassium, benzene, and chlorobenzene. This contamination was detected in downgradient well G-105 at significantly higher concentrations than upgradient wells G-106 and G-107, indicating that Sand Park is the source of the contamination.

This contaminant plume is moving in conjunction with groundwater in a northwesterly direction, away from landfilled areas in the southern and central portions of the site.

Given the high hydraulic conductivities of aquifer materials, the high groundwater flow velocities, and the lateral movement of contamination to well G-105 on the northern property line, it is assumed that contamination has migrated off-site. The full extent of this migration is unknown. On-site contamination has not spread vertically throughout the upper aquifer as evidenced in well nest G-104 and G-105. Deep well G-104 is screened at the bottom of the upper aquifer and remains unaffected. This may be in part due to the upward vertical gradient found in the upper aquifer.

One of the objectives of this study was to determine the effect of Sand Park Landfill on Loves Park's municipal wells, particularly well 2. This well is contaminated with volatile organic compounds, and Sand Park was thought to be one of the sources. The results of this study suggest that Sand Park may not be contributing to the municipal well problem. The reasons for this are as follows:

- Loves Park well 2 is screened in the lower sand and gravel aquifer and thus it is separated from the upper aquifer which is contaminated by Sand Park by a 19-foot clay layer.
- This clay layer and the upward vertical gradient found in the upper aquifer could combine to prevent the downward migration of contaminants into the lower aquifer.
- Based on groundwater flow directions calculated for the upper aquifer, well 2 is not downgradient of any known Sand Park fill areas.
- Organic contaminants detected in well 2 have not been detected in any of the Sand Park monitoring wells.

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